



## DISC HANDLING APPARATUS

**Field of the Invention**

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The present invention relates to disc handling apparatus and methods, and to associated disc machining apparatus and methods. In particular, but without limitation, the present invention is concerned with apparatus for or for  
10 use in apparatus for skimming discs.

**Background to the Invention**

Compact discs (CDs) are commonplace. They are frequently  
15 used for the recording data, sound and images. Currently they are usually a write-once, read-many media. As a result, if not used they become a waste product. To take, for example, the music industry many thousands of CDs are disposed of annually which increases costs and harms the  
20 environment. It is desirable therefore to re-process CDs where possible.

A CD is typically made up of a polycarbonate substrate layer bearing an aluminium reflective layer over which is  
25 a protective lacquer and finally (optionally) information may be printed on the outer surface (opposite the polycarbonate substrate) of the CD. Typically, a CD is 120mm in diameter and 1.2mm thick circular cylindrical disc.

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It is desirable to recover in particular the polycarbonate substrate layer without the contamination of the other layers.

It is known to use chemical techniques to etch off the non-polycarbonate layers to retrieve the substrate. However, generally such techniques require heat and  
5 moisture resulting in chemical alteration of the polycarbonate material. This is wasteful, potentially harmful to the environment in other ways and reduces the value and usefulness of the resultant polycarbonate material.

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After processing, generally the polycarbonate material is compounded, blended and pelletised for subsequent re-use.

It is an aim, therefore, of preferred embodiments of the  
15 present invention to provide an apparatus and method better suited for and/or for use in the retrieval of polycarbonate from compact discs and other similar products.

20 It is an aim of preferred embodiments of the present invention to provide an improvement over the prior art.

#### Summary of the Invention

25 According to a first aspect of the present invention, there is provided a disc handling apparatus comprising a chuck for holding a disc, suction means for sucking such a disc on to the chuck and blowing means for blowing such a disc away from the chuck.

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By providing pneumatic engagement and disengagement for the disc a rapid throughput can be obtained.

Suitably, the chuck is a rotatable chuck.

Suitably, the blowing means comprises a first blowing means arranged to blow the disc away from and above  
5 relative to the chuck (ie generally parallel to the axis of rotation of the chuck).

Suitably, the blowing means comprises a second blowing means arranged to blow the disc away from above the chuck.  
10 Suitably, the disc is blown generally perpendicular to the axis of rotation of the chuck.

Suitably, the apparatus is arranged sequentially to suck the disc on to the chuck, to blow the disc away from and  
15 above the chuck and then to blow the disc away from above the chuck.

Suitably, the sucking means is disengaged prior to the engagement of the means to blow the disc away from the  
20 chuck.

Suitably, the sucking means comprises two levels of suction, one greater than the other.

25 Suitably, the apparatus is arranged to suck a disc on to the chuck first with the lower level of suction and later with the increased level of suction. The first lower level of suction helps position and seat the disc. The second greater level of suction secures the disc relative to the  
30 chuck.

Suitably, air channels are provided through the chuck to suck and/or blow the disc.

Suitably, the apparatus further comprises a chute for delivery of a disc to the chuck. Suitably, the chute comprises a retractable stop for holding a disc adjacent  
5 the chuck.

Suitably, the chute includes means for slowing a disc in the disc's approach to the chuck. Suitably, the slowing means comprises a friction device for engaging the disc  
10 and slowing the disc's movement along the chute by friction.

Suitably, the apparatus further comprises an exit slot whereby the apparatus is arranged to blow a disc through  
15 the exit slot.

Suitably, a tool is provided to work the disc while it is on the chuck.

20 Suitably, the tool comprises a grinding tool for removing a thickness of the disc. Suitably, the tool is movable forwards and away from the axis of rotation of the chuck. Suitably, the tool is biased towards the chuck. Suitably, the tool is adjustably biased towards the chuck. Suitably,  
25 the apparatus further comprises a motor to drive the tool.

Suitably, the apparatus further comprises a disc loading assembly for loading a disc. Suitably, the disc loading assembly comprises a hopper for holding a plurality of  
30 discs. Suitably, the hopper comprises a blower for blowing gas at the region of the hopper from which discs are loaded. Such an air source helps separate the discs prior to pick-up and loading.

Suitably, the disc loading assembly further comprises a pick-up assembly for lifting a disc from the top of the hopper, moving the disc to the correct position and  
5 depositing the disc. Suitably the pick-up assembly comprises means for engaging the disc by a suction cup. Suitably, the pick-up assembly comprises a rotatable arm.

Suitably, the disc loading assembly further comprises a  
10 sensor for detecting when the hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.

Suitably, the disc handling apparatus is suitable for use  
15 with compact discs.

According to the present invention in a second aspect, there is provided a method of handling discs, which method comprises the steps of providing a disc, sucking the disc  
20 on to a chuck and blowing the disc away from the chuck.

Suitably, the chuck is rotated during the sucking and blowing operations.

25 Suitably, a first blowing means blows the disc away from and above relative to the chuck (ie generally parallel to the axis of rotation of the chuck).

Suitably, a second blowing means blows the disc away from  
30 above the chuck. Suitably, the disc is blown generally perpendicular to the axis of rotation of the chuck.

Suitably, the method includes the sequential steps of sucking the disc on to the chuck, blowing the disc away from and above the chuck and then blowing the disc away from above the chuck. Suitably, prior to the disc being  
5 blown above the chuck, the sucking is disengaged.

Suitably, the disc is sucked on to the chuck first with a lower level of suction and later with an increased level of suction. The first lower level of suction helps  
10 position and seat the disc. The second greater level of suction secures the disc relative to the chuck.

Suitably, there is further provided a chute for delivery of a disc to the chuck. Suitably, the chute comprises a  
15 retractable stop for holding a disc adjacent the chuck.

Suitably, the disc is slowed in the disc's approach to the chuck. Suitably, the disc is slowed by a friction device for engaging the disc and slowing the disc's movement  
20 along the chute by friction.

Suitably, there is further provided an exit slot through which a disc is blown after processing.

25 Suitably, a tool works the disc while it is on the chuck.

Suitably, the tool comprises a grinding tool which removes a thickness of the disc. Suitably, the tool moves forwards and away from the axis of rotation of the chuck. Suitably,  
30 the tool is biased towards the chuck. Suitably, the tool is adjustably biased towards the chuck.

Suitably, there is further provided a disc loading assembly for loading a disc. Suitably, the disc loading assembly comprises a hopper for holding a plurality of discs. Suitably, the hopper comprises a blower which blows  
5 gas at the region of the hopper from which discs are loaded. Such an air source helps separate the discs prior to pick-up and loading.

Suitably, there is further provided a pick-up assembly  
10 which lifts a disc from the top of the hopper, moves the disc to the correct position and deposits the disc. Suitably the disc is engaged by a suction cup. Suitably, the suction cup is provided on a rotatable arm.

15 Suitably, a sensor detects when the hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.

Suitably, the disc handling assembly is suitable for use  
20 with compact discs.

According to the present invention in a third aspect, there is provided a disc machining apparatus comprising a chuck for holding a disc in a disc position, a machining  
25 tool, means for rotating such disc relative to the machining tool, and means for driving the machining tool across the disc position, in which the driving means is configured to drive the machining tool at a first speed in a first outer annulus of the disc position and at a second  
30 speed (different from the first speed) in a second inner annulus of the disc position, which first speed is lower than the second speed.



By changing the speed at least once the dwell time of the disc can be reduced while maintaining a high quality of machining.

- 5 Suitably, the machining tool is configured initially to start from outside the edge of the disc position and the driving means is configured to drive the tool to the edge of the disc position at a third speed higher than said first or second speeds.

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Suitably, the machining tool is driven towards the centre of the disc position.

- According to the present invention in a fourth aspect,  
15 there is provided a method of machining a disc, the method comprising the steps of: rotating a disc relative to a machining tool, driving the machine tool across the disc, wherein the machine tool is driven at a first speed in a first outer annulus of the disc and that a second speed  
20 (different from the first speed) in second inner annulus of the disc, which first speed is lower than the second speed.

- Suitably, the machining tool starts from outside the edge  
25 of the disc and the tool is driven to the edge of the disc at a third speed higher than said first or second speeds.

Suitably, the machining tool is driven towards the centre of the disc.

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According to the present invention in a fifth aspect, there is provided a method of machining compact discs, which method comprises the step of removing at least one

layer from the compact disc by rotating the compact disc relative to a machine tool and using the machine tool to remove the at least one layer.

- 5 The method according to the fifth aspect of the invention can be modified according to any of the preceding aspects of the invention.

#### Brief Description of Drawings

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The present invention will now be described, by way of example only, with reference to the drawings that follow; in which:

- 15 Figure 1 is a front view of a skimming apparatus according to the present invention,

Figure 2 is a side view of the skimming apparatus shown in Figure 1,

20

Figure 3 is an enlarged front view of the skimming assembly shown in Figures 1 and 2.

- 25 Figure 4 is an enlarged cut-away plan view of the skimming assembly of Figure 3.

Figures 5a - 5c are a schematic illustrations of a vacuum changeover unit for use with the present invention.

#### 30 Description of the Preferred Embodiments

Referring to the drawings that follow, there is shown a CD skimming apparatus 2 comprising feet 4 acting as the base

of support legs 6 which mount a control unit 8, a CD  
skimming assembly 10 and a CD stack and supply unit 12.

The control unit 8 comprises a metal box housing the  
5 electronics (primarily a programmable logic controller  
("PLC")), the electrical contactors, power supplies, motor  
speed controllers and pneumatics for the apparatus. The  
front panel of the control unit 8 includes the operator  
interface controls indicated generally at 14 including the  
10 start/stop buttons and system indicators. Mains electrical  
and air supply connections are made to the control panel  
via isolators (not shown). Atop the control unit is a  
beacon 16 used to alert an operator to various alert  
states of the apparatus.

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A compressor, indicated generally at 17, is provided as a  
source for compressed air for pneumatics on the apparatus  
as required.

20 The CD stack and supply unit 12 comprises a circular  
cylindrical tube hopper 18 defining a hollow space  
suitable for receiving up to 400 music CDs (not shown). At  
the base of circular cylindrical tube hopper 18 is mounted  
a pneumatic ram 20 for driving CDs upwardly towards an  
25 opening 22 in the cylindrical tube 18. A pick-up arm 24 is  
mounted alongside the circular cylindrical tube 18, which  
pick-up arm 24 is mounted at a pivot 26 arranged to rotate  
a pneumatic vacuum suction cup 28 between the vertical  
position shown in Figures 1 and 2 and generally horizontal  
30 position at which point the pneumatic vacuum suction cup  
28 contacts the upper surface of a CD in the circular  
cylindrical tube 18 (or just proud thereof). Beneath the  
pneumatic vacuum suction cup 28 (in its upright vertical

position) is a first CD chute 30 leading to the CD  
skimming assembly 10 described in more detail in relation  
to Figures 3 and 4. Adjacent the top of the tube 18 are  
two sensors 31 arranged to control the upward movement of  
5 the stack of CDs, ie to ensure the uppermost CD is  
positioned correctly for pick-up. A separate sensor (not  
shown) mounted on the pneumatic ram 20 determines when the  
stack of CDs is finished.

10 In Figure 3 the CD skimming assembly is shown with its  
main plate 32 horizontal, although in use, as can be seen  
from Figures 1 and 2, it is mounted at about 30° to the  
horizontal to gravity feed the CDs.

15 The CD skimming assembly 10 comprises a second CD chute 34  
defined by plate 32 and side walls 36 (only one visible in  
Figure 3, the other having been removed for ease of  
illustration and explanation). A plastics wiper blade 37  
(Figure 3), to provide friction as a CD passes underneath,  
20 is mounted over the second CD chute 34. In the main plate  
32 is provided a turntable in the form of a pneumatic  
chuck 38 mounted on an axle 40 in a running joint 42. The  
pneumatic chuck 38 has a plurality of holes 39  
therethrough through which pneumatic pressure (blow) and  
25 vacuum (suck) can be provided to a CD on the chuck 38 from  
a vacuum changeover unit indicated schematically at 43,  
further details of which are given below. The axle 40 is  
further supported by pillow-box supports 44 and is driven  
by a spindle motor 46.

30

A retractable stop 47 comprising a pneumatically driven  
finger is mounted beneath the second CD chute 34 just  
before the chuck 38. The stop 47 can protrude into the

pathway of the second CD chute 34 to block the passage of a CD on to the chuck 38 and be withdrawn to permit passage. A CD 49 is shown held by the stop 47.

- 5 The main plate 32 carries a first support block 48 and a second support block 50 which between them mount a linear slide assembly 52, which includes a support arm 54.

A cutting device 58 is pivotally mounted on support arm  
10 54. The cutting device 58 comprises a spindle motor 60 driving a tungsten carbide rotary cutting tool 62. The linear slide assembly 52 is driven by a traverse pneumatic cylinder 56 arranged to drive the cutting device 58 towards and away from pneumatic chuck 38. The cutting  
15 device 58 is adjustably biased towards the main plate 32 by a depth of cut cylinder 64.

Adjacent the chuck 38 is an exit slot 66 in side walls 32 of second CD chute 34, which exit slot 66 leads to a  
20 collection bin (not shown). An air knife 68 is provided adjacent the chuck 38 on the side opposite the exit slot 66.

In use a hopper 18 full of CDs 49 is inserted as shown and  
25 the apparatus actuated with the coated surface of the polycarbonate substrate of the CD uppermost. While the apparatus 2 is in operation, the chuck 38 is continuously rotated by spindle motor 46 and the cutting tool 62 is continuously driven by spindle motor 60.

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Pneumatic ram 20 drives the stack of CDs upward towards opening 22. The presence of an upper CD is registered by sensors 31 and the pick-up arm 24 is actuated to rotate

its vacuum suction cup 28 to engage the upper surface of the upper CD (which at this point is generally horizontal). In the hopper 18 an air jet (indicated schematically at 19) is blown at the top few (typically  
5 three) CDs from compressor 17 which encourages separation between the CDs so that when the top CD is picked up, it releases cleanly from the next CD in the stack.

The pick-up arm 24 rotates about pivot 26 to bring the CD  
10 roughly to the vertical, at which point the suction on suction-cup 28 is disengaged to release the CD in to first CD chute 30 which guides the CD to second CD chute 34. The wiper blade 37 slows the progress of the CD as it reaches stop 47. (This is the position shown in Figure 4). A  
15 sensor (not shown) registers the successful ejection of a preceding CD and when the chuck 38 is free the stop 47 is retracted releasing the CD in to the remaining part of second CD chute 34 to chuck 38 by a gravity feed.

20 As the CD is released from the stop 47 to the chuck 38, the CD stack and supply unit 12 is actuated to provide another CD. Thus while the apparatus is machining a CD on the chuck 38 a further CD is waiting behind stop 47 ready to be delivered to chuck 38 as soon as the preceding CD  
25 has cleared the chuck 38 of 875 revolutions per minute (rpm).

As a CD arrives at chuck 38 the vacuum changeover unit provides low vacuum to assist seating of the CD on the  
30 chuck 38. Full vacuum is then engaged to locate and clamp the CD to the rotating chuck 38. The gradationally increased vacuum ensures the CD locates on the chuck 38 and is quickly up to the chuck speed.

Once full vacuum has been engaged, the cutting device 58 is driven towards the CD substantially on a radius thereof by traverse pneumatic cylinder 56. The cutting device 58 is driven from a home position spaced from the CD to the edge of the CD at maximum speed. Once the cutting device reaches the edge of the CD it proceeds from the edge of the CD to 15mm in from the edge at a slow speed to allow the cutting tool 62 to mount the CD and to cut the first and fastest moving annulus of the CD. After the first 15mm the speed is increased to a higher speed to complete the stroke of the cutting device 58 to just beyond the nominal centre-point of the CD on chuck 38. The higher speed is intermediate the slow speed and the maximum speed. The cutting device 58 is then driven to its home position at maximum speed.

The cutting tool 62 rotates at 23,000 rpm to machine away a depth of the CD to skim off the metallic, lacquer and print (if present) layers leaving just the polycarbonate substrate for subsequent reprocessing.

Once the cutting tool 62 is clear of the disc, the vacuum changeover unit 43 switches to full blow to release the CD from the chuck 38 and to lift it up away from the surface of the chuck 38 by a few millimetres. Air knife 68 is then engaged to blow the CD in a direction generally perpendicular to the axis of rotation of the chuck 38 through exit slot 66 (see CD 49a in Figure 4)), to the collection bin (not shown). A sensor (not shown) monitors the ejected CD as it exits. A non-ejection event suspends the sequence and places the apparatus in to an alarm condition.

The next CD waiting on second CD chute 34 is released by stop 47 on to the chuck 38 to repeat the process, until the hopper 18 is empty at which point the apparatus stops  
5 and enters an alarm state waiting for the hopper 18 to be re-filled.

The entire sequence from release by the stop 47 to ejection from the chuck 38 after machining takes  
10 approximately 3.5 seconds.

To adjust the cutting depth of the tool 62, the depth of cut cylinder 64 is adjusted to increase (for a deeper cut) or decrease (for a shallower cut) the bias of the tool 62  
15 towards the CD.

A plurality of such apparatus may be provided in which case a conveyor (not shown) can be provided to receive ejected CDs for delivery to a common collection bin (not  
20 shown).

Referring to Figures 5a - 5c of the drawings that follow, the vacuum changeover unit 43 is illustrated in three different modes of operation and includes a vac/blow motor  
25 as indicated schematically at 101.

Referring to 5a of the drawings that follow (Figures 5b and 5c are similar, but in a different configuration), the vacuum changeover unit has a blow inlet 100 from a blow  
30 outlet 102 of vac/blow motor 101 and a vacuum (or suction inlet 104 from the suction outlet 106 of vac/blow motor 101).



Also provided is a pneumatic connection 108 to the chuck 38.

5 The changeover unit 43 comprises a first valve 110 adjacent the suction inlet 106 and a second valve 112 adjacent the blow inlet 100. The first valve 110 comprises a first piston 114 that can be retracted (Figures 5a and 5c) or extended (Figure 5b) position according to its pneumatic control.

10

The second valve 112 comprises a second piston 116 that can be retracted (Figure 5c) or extended (Figures 5a and 5b) according to its pneumatic control.

15 In the retracted position of first piston 114 the suction inlet 104 and therefore the pneumatic chuck connection 108 are in fluid communication with atmosphere; and the blow inlet 100 may be to atmosphere dependent on the position of second piston 116. In the extended position of second  
20 piston 116 the blow inlet 100 is blocked off from the suction inlet 104 and pneumatic chuck connection 108, while in the retracted position of second piston 116 the blow inlet 100 is in fluid communication with both the suction inlet 104 and the pneumatic chuck connection 108.  
25 The blow inlet 100 is placed in the region of the stroke of second piston 116.

In use the chuck 38 requires three modes: partial suction (Figure 5a) used to initially locate the CD 49 on the  
30 chuck 38; full suction (Figure 5b) used to locate and secure the CD 49 on the chuck 38; and full blow (Figure 5c) to release the CD 49 from the chuck 38 to enable

ejection of the CD49 which are achieved as follow, the letters referring to the Figures 5a - 5c.

By retracting the second piston 116 a bleed to atmosphere  
5 is provided to diminish the reduced pressure effect of the suction.

Other pneumatic arrangements can be used, but currently this is preferred due to its simplicity, minimal number of  
10 moving parts and reliance on a minimum number of compressors/air sources.

The preferred embodiments of the present invention can be used for other similar discs such as Digital Versatile  
15 Discs ("DVD's"), also referred to as Digital Video Discs. It can even be used for double-sided DVD's by grinding of a polycarbonate layer and the sandwiched metallic and lacquer layers to leave a polycarbonate substrate. In the appended claims, the term "compact disc" is used to  
20 indicate DVDs and other like products including CD-ROMs, Enhanced CDs, CD-Rs, CD-RWs, Photo CDs and Super Audio CDs all of which have a substrate material with unwanted layers coated thereon.

25 The apparatus described herein is mainly intended for circular cylindrical discs, but it is not limited thereto.

Thus, embodiments of the present invention provide a disc handling apparatus and a corresponding method of handling  
30 discs, together with a disc machining apparatus and method of machining discs.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this  
5 specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and  
10 drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

15 Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each  
20 feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel  
25 one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

**Claims**

1. A disc handling apparatus comprising a chuck for holding a disc, suction means for sucking such a disc  
5 on to the chuck and blowing means for blowing such a disc away from the chuck.
2. A disc handling apparatus according to claim 1, in which the chuck is a rotatable chuck.
- 10 3. A disc handling apparatus according to claim 1 or claim 2, in which the blowing means comprises a first blowing means arranged to blow the disc away from and above relative to the chuck (ie generally parallel to  
15 the axis of rotation of the chuck).
4. A disc handling apparatus according to any preceding claim, in which the blowing means comprises a second blowing means arranged to blow the disc away from  
20 above the chuck.
5. A disc handling apparatus according to claim 4, in which the disc is blown generally perpendicular to the axis of rotation of the chuck.
- 25 6. A disc handling apparatus according to any preceding claim, in which the apparatus is arranged sequentially to suck the disc on to the chuck, to blow the disc away from and above the chuck and then to blow the  
30 disc away from above the chuck.
7. A disc handling apparatus according to any preceding claim, in which the sucking means is disengaged prior

to the engagement of the means to blow the disc away from the chuck.

8. A disc handling apparatus according to any preceding  
5 claim, in which the sucking means comprises two levels of suction, one greater than the other.

9. A disc handling apparatus according to claim 8, in  
10 which the apparatus is arranged to suck a disc on to the chuck first with the lower level of suction and later with the increased level of suction.

10. A disc handling apparatus according to any preceding  
15 claim, in which air channels are provided through the chuck to suck and/or blow the disc.

11. A disc handling apparatus according to any preceding  
20 claim, in which the apparatus further comprises a chute for delivery of a disc to the chuck.

12. A disc handling apparatus according to claim 11, in  
which the chute comprises a retractable stop for holding a disc adjacent the chuck.

25 13. A disc handling apparatus according to claim 11 or claim 12, in which the chute includes means for slowing a disc in the disc's approach to the chuck.

14. A disc handling apparatus according to claim 13, in  
30 which the slowing means comprises a friction device for engaging the disc and slowing the disc's movement along the chute by friction.

15. A disc handling apparatus according to any preceding claim, in which the apparatus further comprises an exit slot whereby the apparatus is arranged to blow a disc through the exit slot.
- 5
16. A disc handling apparatus according to any preceding claim, in which a tool is provided to work the disc while it is on the chuck.
- 10
17. A disc handling apparatus according to claim 16, in which the tool comprises a grinding tool for removing a thickness of the disc.
18. A disc handling apparatus according to claim 16 or  
15 claim 17, in which the tool is movable forwards and away from the axis of rotation of the chuck.
19. A disc handling apparatus according to any one of claims 16 to 18, in which the tool is biased towards  
20 the chuck.
20. A disc handling apparatus according to claim 19, in which the tool is adjustably biased towards the chuck.
- 25
21. A disc handling apparatus according to any one of claims 16 to 20, in which the apparatus further comprises a motor to drive the tool.
22. A disc handling apparatus according to any preceding  
30 claim, in which the apparatus further comprises a disc loading assembly for loading a disc.

23. A disc handling apparatus according to claim 22, in which the disc loading assembly comprises a hopper for holding a plurality of discs.
- 5 24. A disc handling apparatus according to claim 23, in which the hopper comprises a blower for blowing gas at the region of the hopper from which discs are loaded.
- 10 25. A disc handling apparatus according to claim 23, in which the disc loading assembly further comprises a pick-up assembly for lifting a disc from the top of the hopper, moving the disc to the correct position and depositing the disc.
- 15 26. A disc handling apparatus according to claim 25, in which the pick-up assembly comprises means for engaging the disc by a suction cup.
- 20 27. A disc handling apparatus according to claim 25 or claim 26, in which the pick-up assembly comprises a rotatable arm.
- 25 28. A disc handling apparatus according to claim 23, in which the disc loading assembly further comprises a sensor for detecting when the hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.
- 30 29. A disc handling apparatus according to any preceding claim, in which the disc handling apparatus is suitable for use with compact discs.

30. A method of handling discs, which method comprises the steps of providing a disc, sucking the disc on to a chuck and blowing the disc away from the chuck.
- 5 31. A method of handling discs according to claim 31, in which the chuck is rotated during the sucking and blowing operations.
- 10 32. A method of handling discs according to claim 30 or claim 31, in which a first blowing means blows the disc away from and above relative to the chuck (ie generally parallel to the axis of rotation of the chuck).
- 15 33. A method of handling discs according to any one of claims 30 to 32, in which a second blowing means blows the disc away from above the chuck.
- 20 34. A method of handling discs according to claim 33, in which the disc is blown generally perpendicular to the axis of rotation of the chuck.
- 25 35. A method of handling discs according to any one of claims 30 to 34, in which the method includes the sequential steps of sucking the disc on to the chuck, blowing the disc away from and above the chuck and then blowing the disc away from above the chuck.
- 30 36. A method of handling discs according to claim 35, in which prior to the disc being blown above the chuck, the sucking is disengaged.



37. A method of handling discs according to any one of claims 30 to 36, in which the disc is sucked on to the chuck first with a lower level of suction and later with an increased level of suction.
- 5 38. A method of handling discs according to any one of claims 30 to 37, in which there is further provided a chute for delivery of a disc to the chuck.
- 10 39. A method of handling discs according to claim 38, in which the chute comprises a retractable stop for holding a disc adjacent the chuck.
- 15 40. A method of handling discs according to claim 38 or claim 39, in which the disc is slowed in the disc's approach to the chuck.
- 20 41. A method of handling discs according to claim 40, in which the disc is slowed by a friction device for engaging the disc and slowing the disc's movement along the chute by friction.
- 25 42. A method of handling discs according to any one of claims 30 to 41, in which there is further provided and exit slot through which a disc is blown after processing.
- 30 43. A method of handling discs according to any one of claims 30 to 42, in which a tool works the disc while it is on the chuck.

44. A method of handling discs according to claim 43, in which the tool comprises a grinding tool which removes a thickness of the disc.
- 5 45. A method of handling discs according to claim 43 or claim 44, in which the tool moves forwards and away from the axis of rotation of the chuck.
- 10 46. A method of handling discs according to any one of claims 43 to 45, in which the tool is biased towards the chuck.
47. A method of handling discs according to claim 46, in which the tool is adjustably biased towards the chuck.
- 15 48. A method of handling discs according to any one of claims 30 to 47, in which there is further provided a disc loading assembly for loading a disc.
- 20 49. A method of handling discs according to claim 48, in which the disc loading assembly comprises a hopper for holding a plurality of discs.
- 25 50. A method of handling discs according to claim 49, in which the hopper comprises a blower which blows gas at the region of the hopper from which discs are loaded.
- 30 51. A method of handling discs according to claim 49 or claim 50, in which there is further provided a pick-up assembly which lifts a disc from the top of the hopper, moves the disc to the correct position and deposits the disc.

52. A method of handling discs according to any one of claims 49 to 51, in which the disc is engaged by a suction cup.
- 5 53. A method of handling discs according to claim 52, in which the suction cup is provided on a rotatable arm.
54. A method of handling discs according to any one of claims 49 to 53, in which a sensor detects when the  
10 hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.
55. A method of handling discs according to any one of  
15 claims 49 to 54, in which the disc handling assembly is suitable for use with compact discs.
56. A disc machining apparatus comprising a chuck for holding a disc in a disc position, a machining tool,  
20 means for rotating such disc relative to the machining tool, and means for driving the machining tool across the disc position, in which the driving means is configured to drive the machining tool at a first speed in a first outer annulus of the disc position  
25 and at a second speed (different from the first speed) in a second inner annulus of the disc position, which first speed is lower than the second speed.
57. A disc machining apparatus according to claim 56, in  
30 which the machining tool is configured initially to start from outside the edge of the disc position and the driving means is configured to drive the tool to

the edge of the disc position at a third speed higher than said first or second speeds.

58. A disc machining apparatus according to claim 56 or  
5 claim 57, in which the machining tool is driven towards the centre of the disc position.

59. A method of machining a disc, the method comprising  
the steps of: rotating a disc relative to a machining  
10 tool, driving the machine tool across the disc, wherein the machine tool is driven at a first speed in a first outer annulus of the disc and that a second speed (different from the first speed) in second inner annulus of the disc, which first speed is lower than  
15 the second speed.

60. A method of machining a disc according to claim 59, in which the machining tool starts from outside the edge of the disc and the tool is driven to the edge of the  
20 disc at a third speed higher than said first or second speeds.

61. A method of machining a disc according to claim 59 or  
claim 60, in which the machining tool is driven  
25 towards the centre of the disc.

62. A method of machining compact discs, which method comprises the step of removing at least one layer from the compact disc by rotating the compact disc relative  
30 to a machine tool and using the machine tool to remove the at least one layer.

63. A method of machining compact discs, in which the disc handling apparatus is according to any one of claims 1 to 29, the method of handling discs is according to any one of claims 30 to 55, the disc machining apparatus is according to claim 56 and/or the method is according to any one of claims 57 to 62.

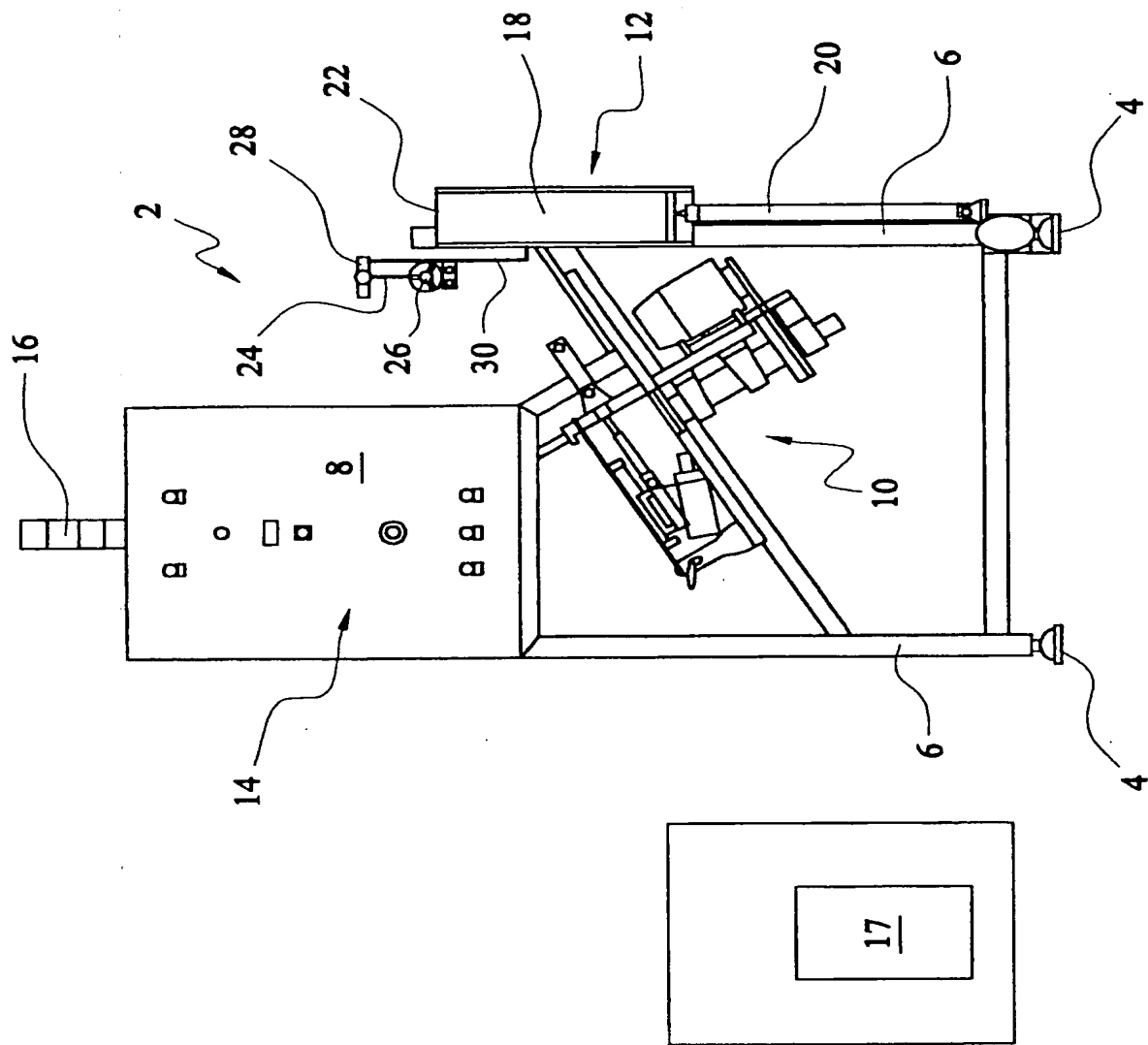


FIG. 1

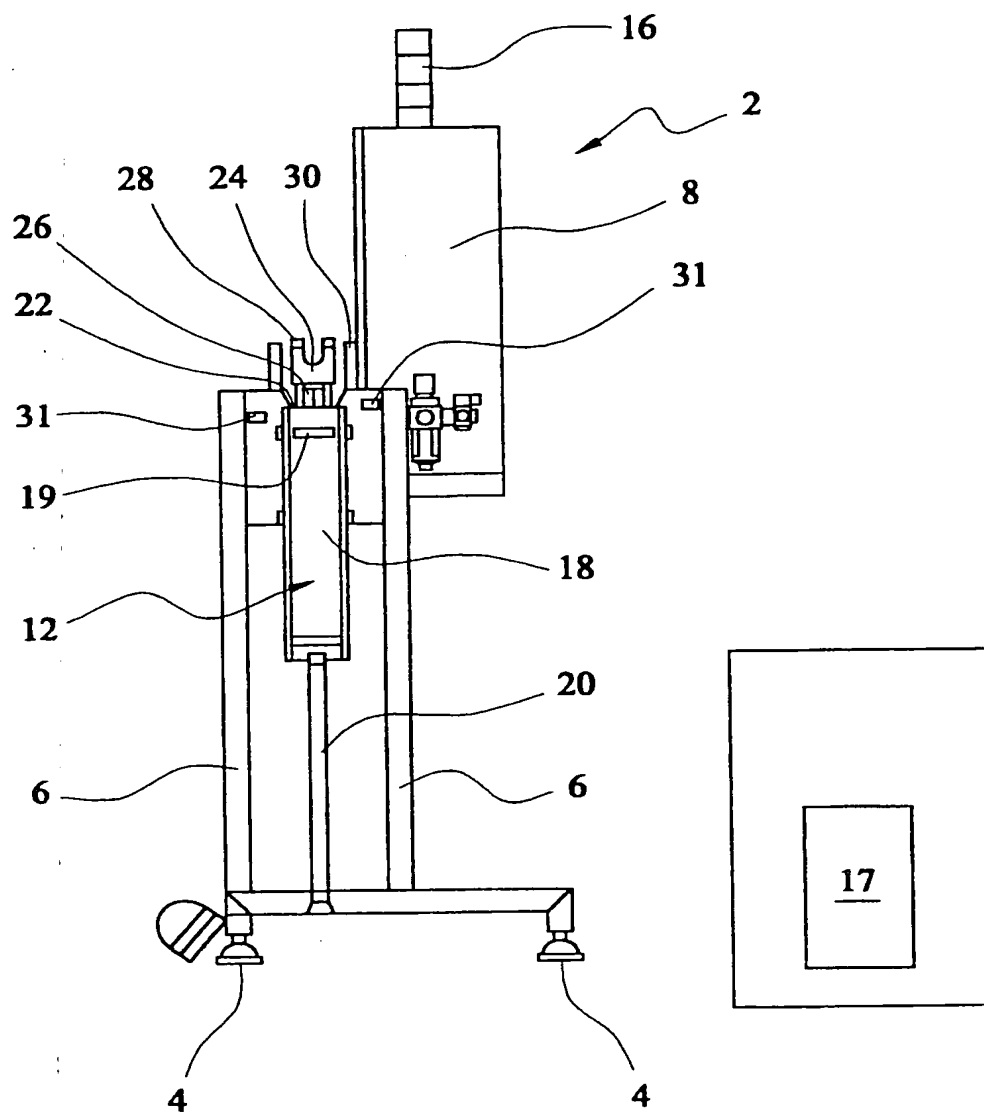
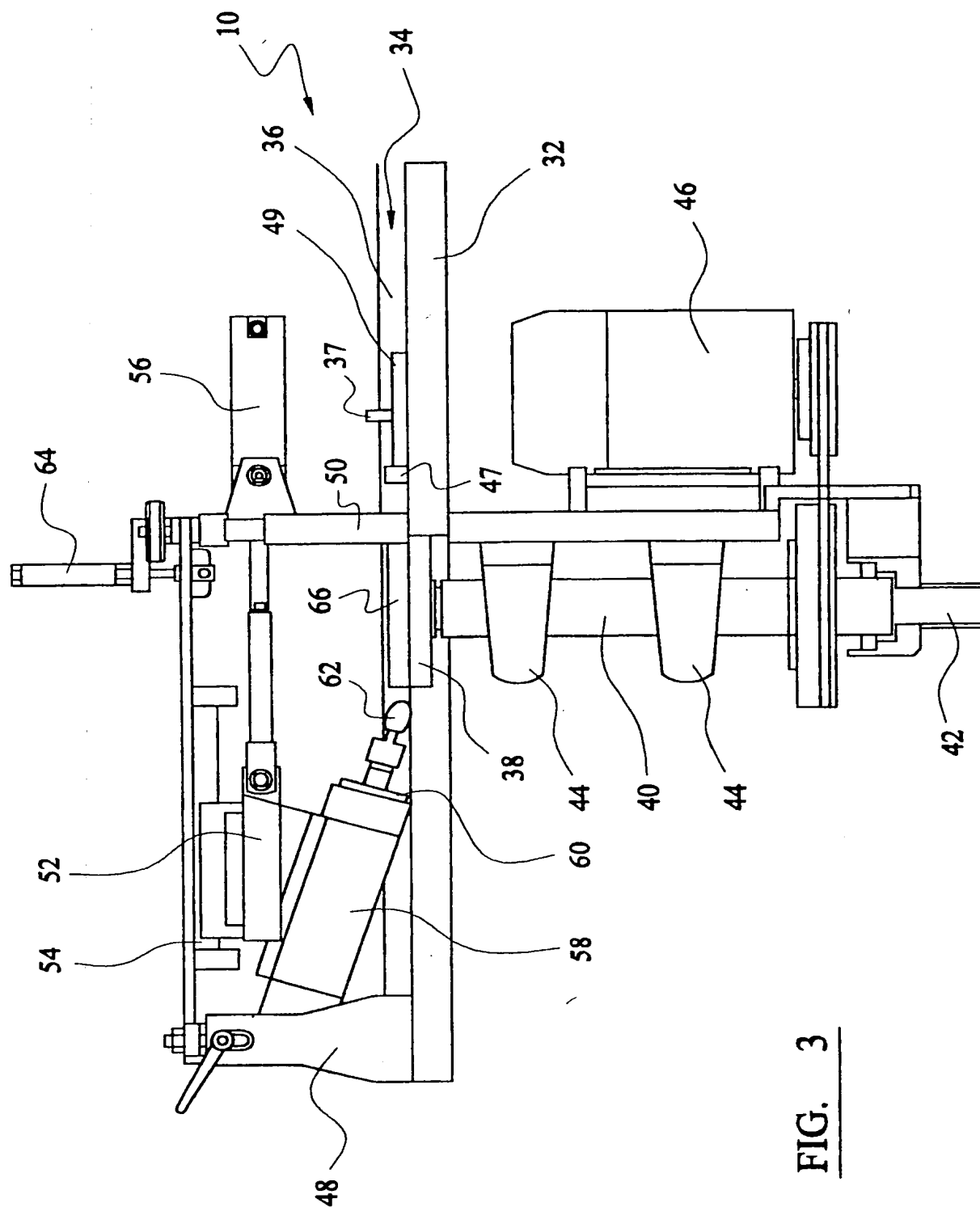


FIG. 2

**-3/5-**





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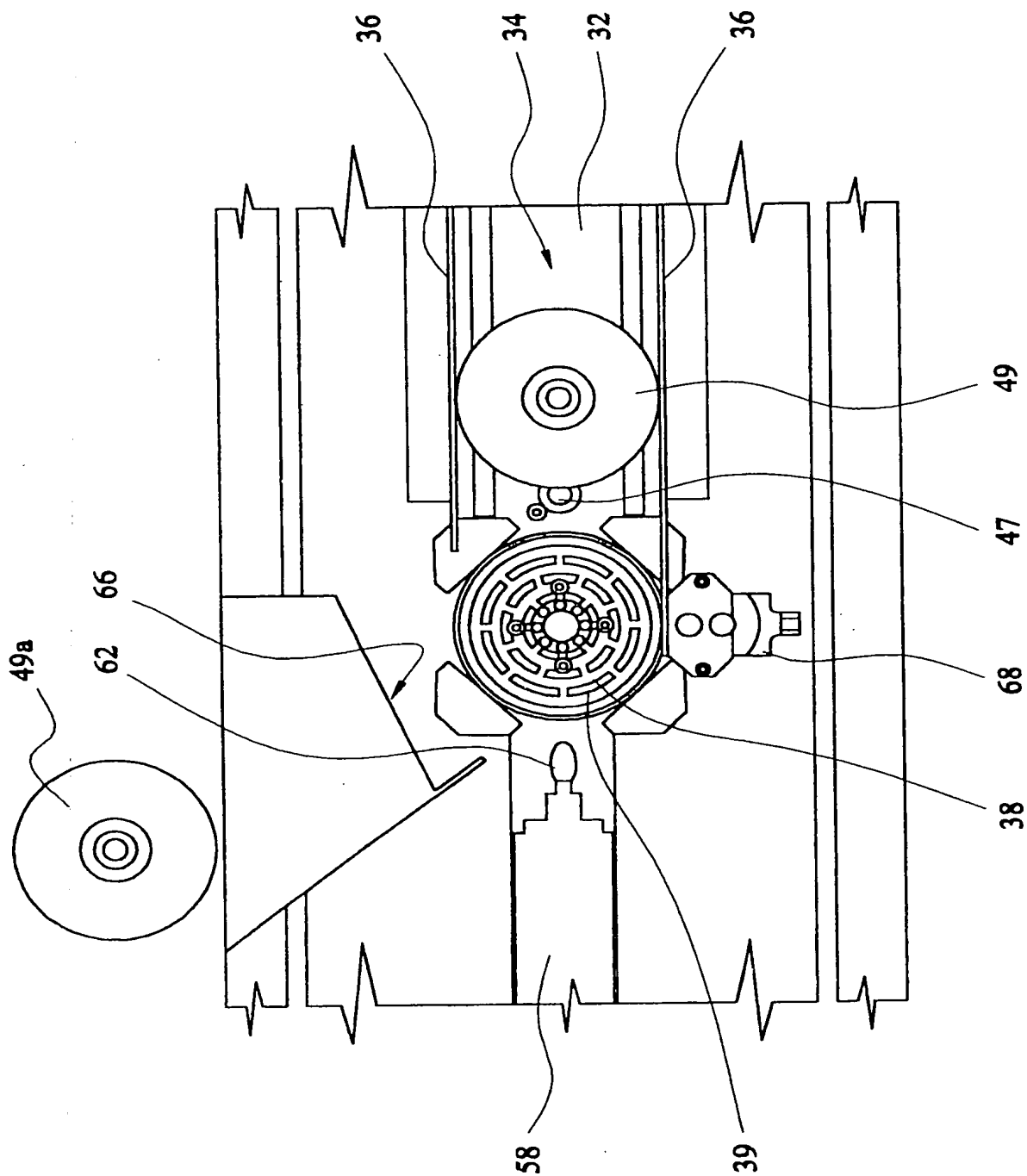
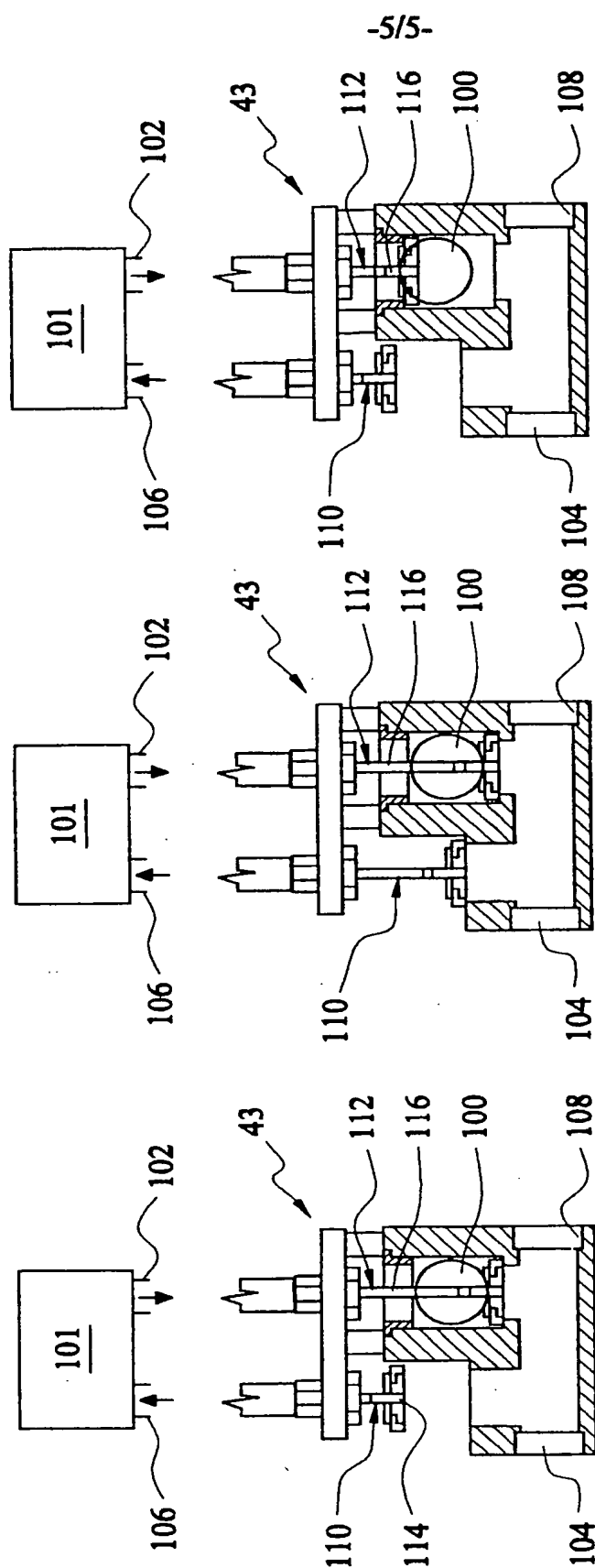


FIG. 4



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 01/00644

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G11B23/50

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	DE 43 40 595 A (LEGNER ECKHARDT ; RHABEK WALTER OTTO (DE); STROMMER CHRISTIAN (AT);) 1 June 1995 (1995-06-01) the whole document	1-63
X	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 04, 31 March 1998 (1998-03-31) -& JP 09 309066 A (KAO CORP), 2 December 1997 (1997-12-02) abstract; figures	1-63



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

18 June 2001

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

International Application No.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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